BUILDING BOXES

NUMBER • MEASUREMENT • GEOMETRY

- Multiplication
- Volume
- Spatial visualization

Getting Ready

What You'll Need

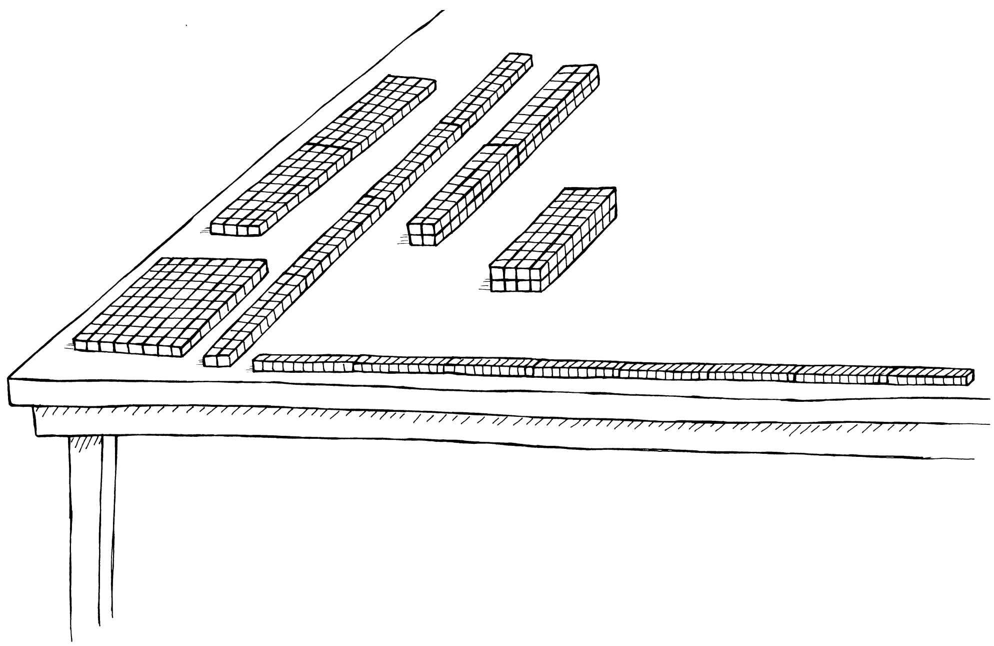
Base Ten Blocks, 1 flat and at least 8 longs per pair

Small closed box

Overview

Children build as many different rectangular prisms as they can from eight Base Ten longs. In this activity, children have the opportunity to:

- explore volume
- discover that rectangular prisms with different dimensions can have the same volume
- use spatial reasoning



The Activity

Tell children that another name for a figure shaped like a box is rectangular prism.

You may wish to explain that the number of cubic units that make up a box is called the volume *of the box.*

Introducing

- Display a small closed box. Establish that each side of the box is a rectangle, a shape that has four square corners and the dimensions of length and width.
- Elicit that the entire box has eight square corners and the dimensions of length, width, and height.
- Hold up a flat and describe it as a kind of box. Allow children to examine the flat and give its dimensions. (Be sure they understand that the flat has a length of 10 units, a width of 10 units, and a height of 1 unit.)
- Ask children to tell how many cubes make up the flat. Accept answers that describe the flat as being made up of 100 cubes, 100 (Base Ten Blocks) units, or 100 cubic units.

On Their Own

How many different boxes can you make from the same number of Base 10 longs?

- Work with a partner. Talk about ways of making a box using Base 10 longs only.
- Now build all the different boxes you can from 8 longs. You may put the longs in 1 layer or in more than 1 layer.
- As you work, make a chart to record the length, width, and height of each box. Also record how many cubic units make up each box.
- Look for patterns in your chart.

The Bigger Picture

Thinking and Sharing

Create a class chart with the headings *Dimensions of Box* and *Cubic Units in Box* (See p. 20). Have pairs contribute their findings. Then discuss the charted data.

Use prompts like these to promote class discussion:

- How did you go about building your boxes?
- What did you do to find the length, width, and height of each box?
- Did you ever think that two boxes were different but later find out that they were really the same? Explain.
- What patterns do you see in the chart?
- How can you use the dimensions of any box to find the total number of cubic units in that box?

Writing

Ask children to describe how to find the number of cubic units that make up a Base Ten Blocks box of any size.

Extending the Activity

1. Challenge children to repeat the activity using 12 longs.
2. Ask children to use longs to build several different boxes, each with a volume of 200 cubic units.

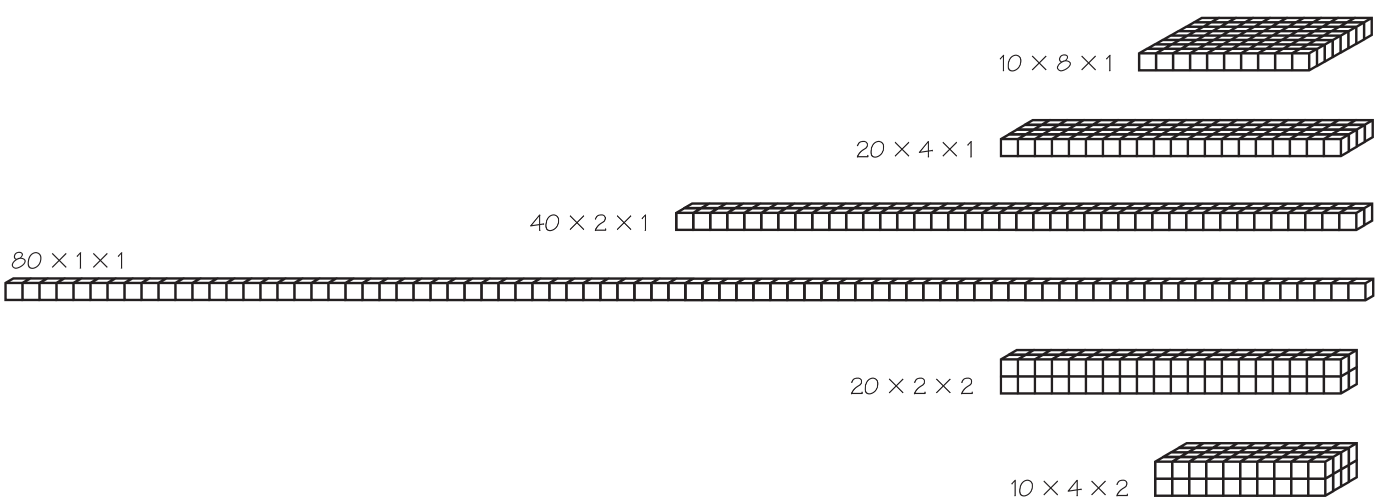
Teacher Talk

Where's the Mathematics?

This activity provides children with a chance to informally explore volume. It also acquaints them with the concept of expressing the volume of a rectangular prism as the product of its dimensions. If you have a sufficient supply of Base Ten Blocks, provide each pair of children with more than the minimum number of 8 longs. Pairs that have access to more than 8 longs will have the advantage of not having to dismantle each box before they can build the next.

Some pairs will approach the task of building the boxes in a random fashion. Other pairs may have a more systematic approach, first building as many one-layer boxes as they can and then building two-layer boxes. They may even go on to build a four-layer box only to discover later that they had already built it, oriented differently, as a two-layer box. Children will discover that they can build six discrete boxes. They should not be surprised to find that all the boxes share the same volume—80 cubic units.

DIMENSIONS OF BOX				CUBIC UNITS IN BOX
Layers	Length	Width	Height	Volume
1	10	8	1	80
1	20	4	1	80
1	40	2	1	80
1	80	1	1	80
2	20	2	2	80
2	10	4	2	80



It is likely that children will record their box dimensions in various ways. Some pairs may simply list the dimensions for a particular box as, for example, "40, 2, 1." Others may be more specific by writing, for example, "The length is 40, the width is 2, and the height is 1." Still others may write "40 by 2 by 1." As you make up the class chart you may wish to record the dimensions using multiplication notation ("$40 \times 2 \times 1$") if children have not already suggested doing so.

After considering the entries in the chart above, for example, a child may say that certain dimensions, such as $4 \times 20 \times 1$, have not yet been listed. Explain that the box represented by these dimensions is the same box represented by the dimensions $20 \times 4 \times 1$, which has already been listed. This issue is likely to arise if children have trouble differentiating between the length and width of some of the boxes they build. Since the way in which the boxes are oriented does not matter for this activity, tell children that they may decide for themselves which dimension is the length and which is the width. (If children find this notion confusing, however, you may want to include all the ways of listing a single set of dimensions in your class chart.)

Children should conclude that each of the boxes they make with 8 longs has a volume of 80 cubic units. Some pairs will simply reason that since they have made each box from the same number of longs of equal length, the total volume of each box must be the same. They may express this mathematically by saying, for example, "Since there are 8 longs, and each has 10 units, the box must have 8×10, or 80 units." Other pairs may find the number of units in each layer of each box and then find the sum of the layers. They may say, for example, "This box has two layers of 40 units each. So, there are 40 plus 40, or 80 units all together." (Note that since we call the smallest Base Ten Block a unit, even though it is actually a cubic unit, allow children to express volume in terms of a total number of units, instead of as cubic units.) Insightful children may notice that multiplying the three dimensions of any box is the easiest way to find the number of (cubic) units that make up the box.

The generalizations that children make as they study the patterns generated in this activity set the stage for deriving and using formulas. If you are confident that children understand the concept of volume, you may wish to ask them to develop their own rule for finding the number of cubic units that make up a box. After children share their ideas, you may choose to present the formula for the volume of a rectangular prism, $V = l \times w \times h$, and elicit children's suggestions for how to apply it.